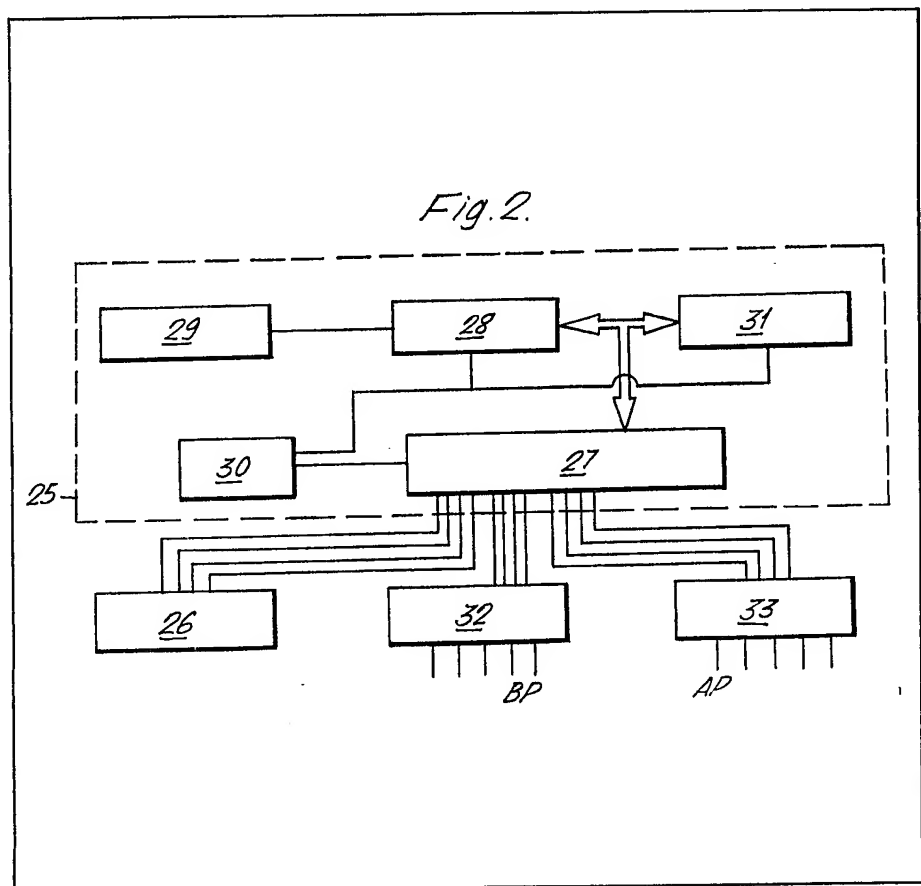


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(54) **Electronic programmer**

(57) A microprocessor (28) based electronic sequence programmer for use e.g. in a washing machine is arranged to control the machine (via interface 33) through an operating cycle with various parameters of the machine being set in accordance with stored (at 31) values appropriate to the operating cycle. The programmer causes the display (through interface 32) of suitable values of parameters (e.g. in its application to a washing machine, the amount of detergent to be used) which are set by the microprocessor, in accordance with other parameters (e.g. fabric type, colour, load and degree of soiling of the clothes to be washed) selected (at 26) by the operator. The sequence of operations controlled by the microprocessor then represents an op-

timum in terms of energy consumption and operating effectiveness.



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Fig. 1.

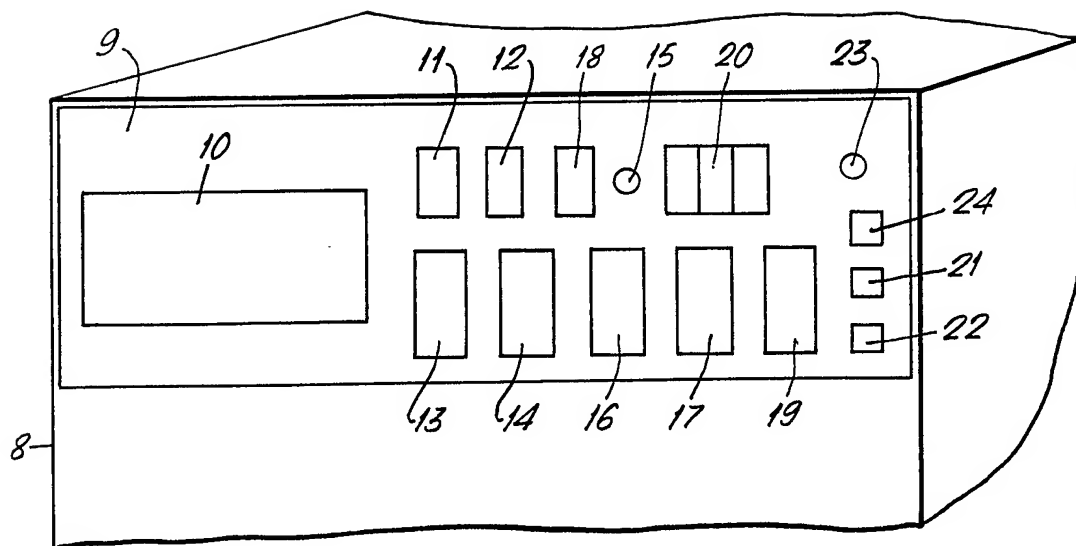
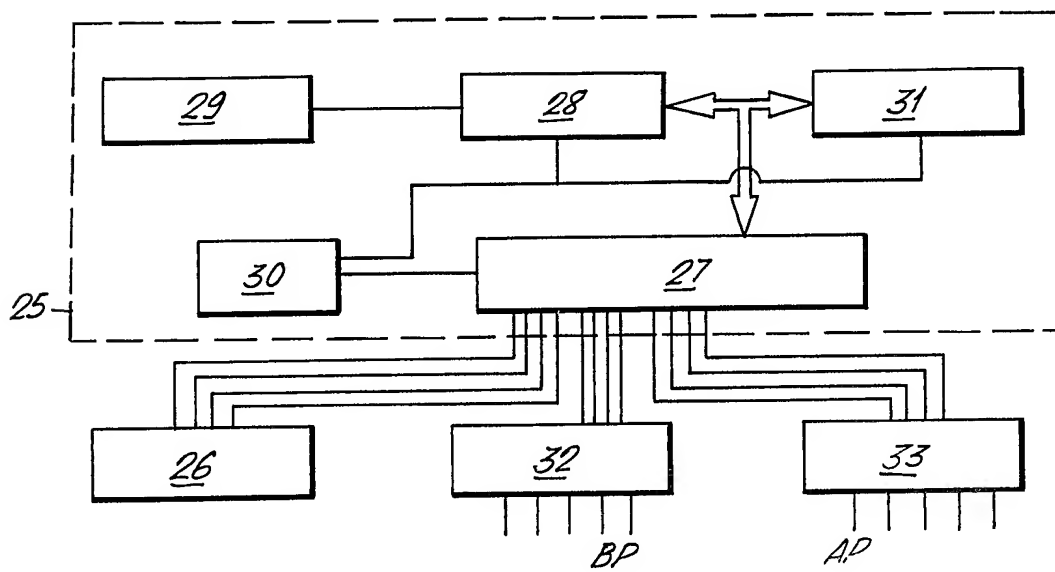
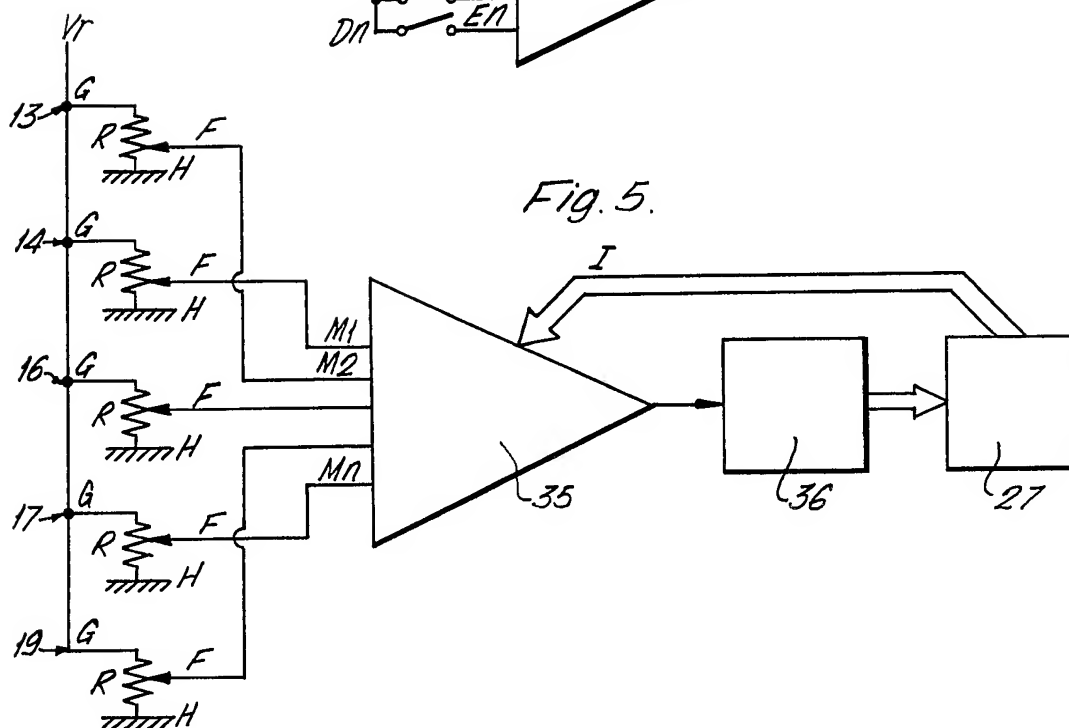
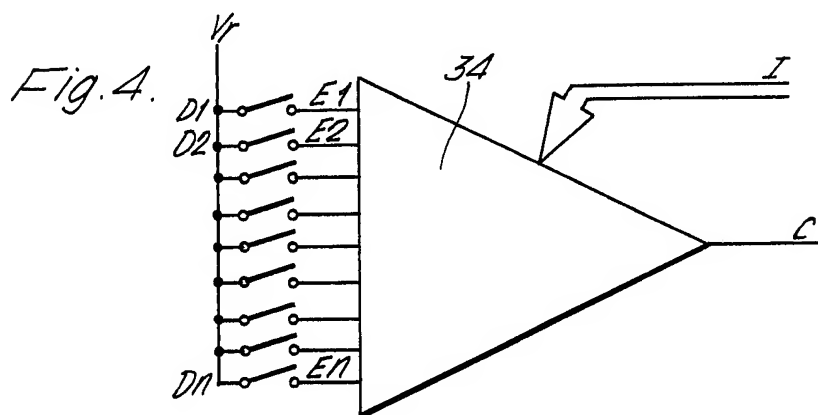
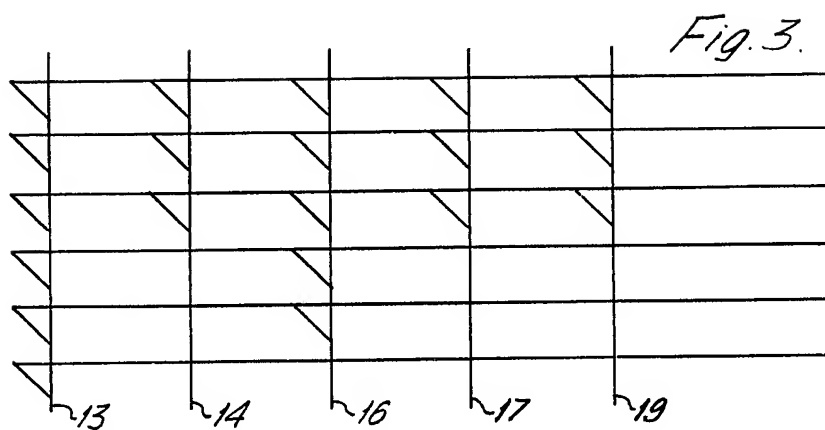


Fig. 2.



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## SPECIFICATION

### Electronic programmer

- 5 The invention relates to an electronic programmer for use in controlling a machine, e.g. a domestic washing machine.

10 It is known that a conventional domestic washing machine can be provided with an electro-mechanical programmer which is capable of causing the machine itself to perform automatically all the operating cycles, in accordance with various predetermined programs which may take into account the characteristics of the fabrics to be washed (type and colour of the fabric, etc), and the degree of soiling of the fabrics.

15 Selection of each program is then effected by acting in advance on the knob of the programmer so as to set it to a position corresponding to the desired program (with the machine switched off), and then switching on the main switch of the machine (push-pull switch) to set the machine in operation and thus to permit the machine automatically to perform the various cycles.

20 Also known are washing machines in which the electro-mechanical programmers have been replaced by electronic programmers which are pre-arranged to operate in accordance with various predetermined programs. Selection of the programs is usually effected (with the machine switched on) by operating firstly one or more push buttons disposed on the control panel of the machine, each of the buttons being associated with a given program, and then switching on a start switch of the machine so as to permit the machine automatically to perform the various cycles included in the selected program or programs. Various types of electronic programmers are known, by means of which each program selected in the manner described above is automatically performed, the programmers determining a succession of switchings on and switchings off of the various operating devices of the machine itself (pumps, motors, electrically operated valves, resistances, etc), and hence the various operating cycles of washing, rinsing, etc. In view of the power saving which is required nowadays to an ever increasing extent, such programmers nonetheless suffer from limitations in as much as they permit the performance of predetermined programs which take account only of the generic characteristics of the clothing to be washing (type and colour of the fabric, degree of soiling thereof), but on the contrary do not take any account of the influence which such characteristics have on each variable which is involved in the mechanics of the washing action. In other words, with the solution described above, it is not possible to optimise the consumption of the machine (in terms, e.g. of detergent, water and electrical power)

70 in dependence on the various functions to be considered in a washing program (characteristics and degree of soiling of the fabric, the amount of detergent required, the water which is introduced into the tub and the hardness of the water, the temperature of the water and the duration of the cycle).

80 According to the present invention, there is provided an electronic programmer for controlling the operation of a machine comprising a plurality of manual selection means operable by the user for setting input data necessary for performance of a desired operating cycle controlled by the programmer, an input-output unit, at least one storage memory for storing the input data provided by said manual selection means, a microprocessor capable of controlling the performance of the operating cycles of a machine controlled by the programmer in dependence on the data from said memory, and a plurality of low-power and high-power interface means respectively for connection to the control and visual display components of the machine and to operating components of the machine wherein each of said manual selection means is associated with a single respective parameter of the operating cycle of the machine and includes at least one electrical control means connectable to or disconnectable from said memory and said microprocessor by way of said input-output unit the electrical control means when in its connecting position being arranged to supply said memory and said microprocessor with a coded control signal corresponding to said parameter, and the microprocessor being arranged to send to said visual display components in reply to the control signals received, at least one coded setting signal corresponding to at least one complementary parameter of the operating cycle of the machine.

95 The invention also provides a domestic washing machine having an electronic programmer, for controlling the operation of the machine, the programmer comprising a plurality of manual selection means disposed on a control panel of the machine for setting input data necessary for performance of a desired operating cycle of the machine, an input-output unit, at least one storage memory for storing the input data provided by said manual selection means, a microprocessor capable of controlling the performance of the operating cycles of the machine in dependence on the data from said memory, and a plurality of low-power and high-power interface means respectively connected to the control and visual display components of the machine, including electrically operated valves, safety devices, viewing means and warning lights and to the operating components of the machine including a motor and a discharge pump, wherein each of said manual selection means is associated with a single respective parameter of the operating cycle of the machine.

chine, the parameters including type of and colour of fabrics and amount of clothing to be washed and includes at least one electrical control means connectable to or disconnectable from said memory and said microprocessor by way of said input-output unit, the electrical control means when positioned in its connecting position being arranged to supply said memory and said microprocessor with a coded control signal corresponding to said parameter, the microprocessor being capable of sending to said visual display components in reply to the control signals received, at least one coded setting signal corresponding to at least one complementary parameter of the operating cycle of the machine including the amount of detergent to be put in the machine for optimisation of said cycle.

The invention will be better understood from the following description given by way of non limitative example with reference to the accompanying drawings in which:

Figure 1 diagrammatically shows the front panel of the washing machine with various selection push buttons;

Figure 2 shows the block circuit diagram of an embodiment of electronic programmer according to the invention;

Figures 3, 4 and 5 show various forms of manual selection means for use in the illustrated embodiment of the invention.

Fig. 1 shows the front panel 9 of a clothes washing machine 8. The front panel 9 comprises: a detergent container 10 with separate compartments, of the openable drawer type; a pre-washing detergent display 11 and a washing detergent display 12, both of the digital type, illumination of the displays indicating respectively the amount of pre-washing detergent or washing detergent which is to be put into the specific compartments of the detergent container 10, which amount is preferably determined by the number of times (indicated on the display) that a suitable measuring container is to be filled with detergent which is then to be poured into the respective compartment of the container 10 (alternatively, any other suitable method of quantifying the amount of detergent may be used, for example by means of reference symbols provided either in the displays or in the detergent container); a first selector 13 for pre-setting the machine in dependence on the type of fabric to be washed, and movable selectively to each of the following positions (type of fabric): cotton, cotton substitute, synthetic, acrylic, pure wool, IWS wool; a second selector 14 for pre-setting the machine in dependence on the colour of the fabric and movable selectively to each of the following positions (type of colour): white, resistant colour, delicate colour; a telltale light 15 formed by LED (light emitting diode) or similar signalling device, and operable to signal trouble within the electronic programmer (by the telltale light

being illuminated), the telltale light remaining extinguished when the electronic programmer is operating correctly; a third selector 16 for pre-setting the machine in dependence on the degree of soiling of the fabric to be washed, and movable selectively to each of the following positions (type of soiling and ensuing phases of the cycle): heavily soiled, normally soiled, lightly soiled, rinsing, spin; a fourth selector 17 for pre-setting the machine in dependence on the load of clothing to be washed, as indicated on a three-position viewing means 18 associated therewith, the fourth selector being movable selectively to each of the following positions indicated by the above-mentioned display (washing load): maximum (basketful), medium (three-quarters basket), and minimum (half basket); a fifth selector 19 for pre-setting the machine in dependence on the hardness of the water introduced into the machine, and movable to each of the following positions (water hardness): hard, average and soft, such positioning being effected only upon installation of the machine; a three-position display 20 for signalling the total duration of the cycle selected in the course of operation (by means of a three-digit number which progressively decreases as the various phases of the cycle are performed); a start-cycle push-button 21 ('START' push button), actuation of which permits the machine to operate when all the parameters determining the operating cycle have been previously selected; a stop-cycle push button 22 ('STOP' push button), which, when actuated for a prolonged period (for a time of at least 2 to 3 seconds) provides for switching off the machine at any moment in the cycle, whereby to re-start the machine again it is necessary to operate again the above-mentioned 'START' push button; a telltale light 23 formed by a LED (light emitting diode) of similar signalling means, and operable to signal to the user the STOP condition of the machine, the telltale light being extinguished when the machine is operating; a 'ON-OFF' push button 24 forming the main switch of the machine: when this switch is in the 'ON' position the machine is connected to the electrical network and thus can operate, but when the switch is in the 'OFF' position the machine is disconnected from the electrical network and hence cannot operate.

Referring now to Fig. 2, it will be seen that the present electronic programmer 25 (indicated in dotted lines) substantially comprises: manual selection means (block 26) comprising the five selectors described above and constructed in ways which will be described hereinafter; an input-output unit 27 which is known per se and which is connected to the means 26 and which is operable to permit or prevent the transmission of data to the means connected downstream of the unit or data which originates from said downstream-con-

nected means and which is directed to said unit; a microprocessor 28 of per se known type, which is connected to the unit 27 and which is operable automatically to control all the operating cycles of the machine, in dependence on the input parameters selected by the manual selection means 26, the microprocessor being supplied from a main electrical supply 29 or from an auxiliary supply 30 formed by a buffer battery or similar device which is switched on automatically in the event of failure in the main power supply; at least one memory 31 of per se known type, which is connected either to the input-output unit 27 or to memories possibly provided within the microprocessor 28, the function of which memory will be described hereinafter.

The memory 31 and the unit 27 are also connected to the auxiliary supply 30 when there is a failure of the main supply 29. The unit 27 is also connected to low-power interface means 32 and to high-power interface means 33, both of per se known type. The low-power interface means 32 are in turn connected to the low-power components of the machine (display telltale lights, electrically operated valves, safety devices), while the high-power interface means 33 are connected to the high-power operating means of the machine (motors, discharge pump, resistances, etc). For the purposes of simplification, in Fig. 2 all the above-mentioned low-power components are indicated by BP, while all the high-power operating devices are indicated by AP.

The interface means and the action thereof on the related electrical devices connected thereto form part of the state of the art.

Fig. 3 shows a first form of the manual selection means 26 (matrix-based). For this purpose, the matrix is diagrammatically formed by a group of vertical and horizontal conductors which intersect with each other and which are connected together by switch means provided at certain ones of their intersections. The vertical conductors are connected to the respective selectors 13, 14, 16, 17 and 19 provided in the front panel 9 in Fig. 1, and are thus used to supply signals corresponding to the input parameters, which are selected by the user acting on said selectors. The horizontal conductors are associated with the respective selection positions of the selectors and are connected by way of the input-output unit 27 to the memory 31 and the microprocessor 28 (see Fig. 2) and, when the vertical conductors are connected in the manner described hereinafter, they transmit the signals corresponding to the input parameters selected by the user of the machine, to the memory and to the microprocessor. Switch means shown in Fig. 3 are associated with some intersections of the matrix, the switch means comprising for example keys, linear sliders, rotary switches, or any other

switching means of similar type. The switching means produce different combinations of the input data supplied by each of the above-mentioned selectors, in dependence on the open or closed position of the switching means.

Fig. 4 shows a second embodiment of the manual selection means 26 (with digital multiplexer). In this case the five selectors mentioned above are made in the form of contacts which are arranged in sequence and which are connected to the inputs of a digital multiplexer 34 whose output C is connected to the input-output unit 27 (Fig. 2). Each contact of the selectors has a terminal which is connected in parallel with corresponding terminals of the other contacts (terminals denoted by  $D_1 \dots D_n$ ) and connected to the reference potential  $V_r$  (earth, ground, etc) and the other terminals connected to the inputs denoted by  $E_1 \dots E_n$ . The input parameters selected with this arrangement are transmitted to the unit 27 in the form of digital signals and in a given sequence which is established by means of suitable digital address signals I supplied by the microprocessor 28 to the digital multiplexer 34 (Fig. 2).

Fig. 5 shows a third embodiment of the manual selection means (by means of potentiometers and an analog multiplexer). In this case the five selectors 13, 14, 16, 17 and 19 are in the form of potentiometers provided respectively with a resistor R and a slider F. Each resistor R is connected with a terminal G in parallel to the respective terminals of the other resistors and to a given positive potential, and is connected to earth with the other terminal H. Each slider F is connected to an input denoted by  $M_1 \dots M_n$  of an analog multiplexer, which performs the same function as the above-described digital multiplexer and which is connected to the input-output unit 27 by way of an analog-digital converter 36. In this case selection of the input parameters is effected by acting on the respective potentiometers and thus with analog input values which are converted into digital values by the converter 36. As described above, in this case also the succession of the input parameters to be transmitted to the unit 27 is established by suitable digital address signals I supplied by the microprocessor 28 to the analog multiplexer 35.

It will be appreciated that there are other possible ways of providing the manual selection means, for example by suitably combining together the switches (which supply digital signals) and potentiometers (which supply analog signals), or by providing means differing from those shown in Figs. 3, 4 and 5, but performing substantially the same function, such as transistors, diodes, photoelectric cells, etc.

Referring now again to the block circuit diagram of the present electronic programmer

(Fig. 2) the mode of operation thereof will now be described. The microprocessor 28 operates only with digital signals and hence it is necessary that the signals supplied thereto are always coded in this form; if this is not the case, it is necessary to provide an analog-digital converter upstream of the microprocessor itself. After the machine has been installed at the desired position and the plug has been inserted into the appropriate socket, the water-hardness selector 19 is set to the corresponding desired selection position (relating to the hardness of the mains water). Such selector does not have to be moved thereafter, except when the machine is provided with decalcifiers or is to be installed at a different place where there is water of a different hardness. According to the type, colour and degree of soiling of the fabric to be washed, the user operates the respective selectors 13, 14 and 16 (contained in the unit 26), whereby the signals corresponding to those input parameters are transmitted to the input-output unit 27 and from there in part to the microprocessor 28 and in part to the memory 31. While the memory 31 stores the signals corresponding to the parameters which the user of the machine selected and which will then be 'drawn' from the microprocessor 28 when the machine is set in operation, the microprocessor performs a different function as soon as it receives the digital signals in the manner described above. A plurality of optimum operating cycles has already been stored in advance in the memory, the optimum operating cycles having been determined on the basis of practical experience and recommendations by various guiding bodies, by means of which the best washing results can be obtained with the minimum consumption of water and detergents used. Consequently, based on the signals corresponding to the parameters selected by the user, the microprocessor 28 automatically establishes the cycle which the machine must perform (vigorous or delicate), the maximum temperatures which must be reached therein, and whether the cycle is to take place with or without pre-washing. The microprocessor also supplies signals relating to the selections made, which signals are transmitted by way of the unit 27 and the low-power interface means 32 to the respective pre-washing and washing detergent display 11 and 12.

Reading the numbers which appear at the displays 11 and 12 indicates to the user the number of measures of detergent which the user must pour into the respective pre-washing and washing compartments of the detergent container 10, thus optimising the consumption of detergent on the basis of the pre-setting in respect of the washing load and the water hardness. Obviously, when the user has selected the 'rinsing' or 'spin' position relative to the degree of soiling of the fabric (by

setting the selector 16 to the desired position), it will not be necessary to pour either pre-washing detergent or washing detergent into the container 10, insofar as the displays 11 and 12 will indicate zero.

Besides indicating the amount of pre-washing detergent and washing detergent in the manner described above, the microprocessor 28 also supplies a reply signal to the three-position display 18 which is associated with the selector 17 for selecting the load of clothing to be washed. This display indicates the maximum load recommended for a certain type of clothing to be washed, by the associated position being lit. When loading is completed, the user can then set the selector 17 to the position closest to that actual position. If the selector 17 is set to a selection position higher than that indicated in the display, the display will signal the error to the user by flashing. If on the contrary the selector is set to a selection position which is lower than that indicated by the display, the pre-washing and washing detergent displays 11 and 12 will indicate the different amount of detergent necessary for achieving a good washing result. Finally, as regards actuation of the selectors, it should be made clear that it is not necessary for actuation to take place in the sequence set out above, but rather actuation may be effected in accordance with any sequence in which the microprocessor will always provide for transmission of the corresponding reply signals to the associated display and hence will always provide for indicating clearly thereon the recommended amounts of detergent and the recommended maximum loads of laundry to be washed. As soon as the selection operations described above have been performed, the machine is pre-set for operation. The start-cycle push button 21 ('START' push button) is then pressed and the operating cycles of the machine are thus started. All the safety devices, which are in conformity with International standards and which are provided in the machine (door locking system, anti-overflow arrangement, etc.), are switched on, while the memory 31 contains the data of the cycles to be performed.

The microprocessor 'draws' such data from the memory 31 from time to time, and thus defines the succession of operations which the machine is to follow in order to perform that cycle, and then transmits corresponding control signals either to the low-power interface means 32 or to the high-power interface means 33. In this way the low-power interface means 32 control either the various electrically operated valves of the machine or the display. In particular, the total duration of the cycle in the course of performance is indicated at the three-position display 20, the magnitude of said total cycle duration progressively falling as the various phases of the cycle are performed, until it reaches the value '000' at

the end of the cycle. Similarly, the high-power interface means 33 control the various high-power operating devices (motors, resistances, etc.) and thus the required sequence of connecting such components to and disconnecting them from the electrical network. By means of suitable reply signals received either from the low-power components or from the high-power operating devices, the microprocessor is capable at any moment of 'advising' of their correct operating condition and the possible presence of trouble therein. When the machine is not operating correctly or some operating device is malfunctioning, the letter 'A' (alarm) is lit on the three-position display 18 for indicating the load of clothing to be washed, while at the pre-washing and washing detergent displays 11 and 12 there appear a respective number with a figure indicating in code the type of trouble diagnosed, on the basis of which it is possible immediately to locate the trouble in the machine. At the same time as the defect is signalled, the machine stops, and discharges the water (when necessary and if possible) and the door locking safety device is switched off. A telltale light 15 already described hereinbefore signals the operating condition of the electronic programmer 25. If the electronic programmer is operating correctly, the telltale light 15 remains extinguished while it is lit if the electronic programmer has broken down. If the machine is to be stopped at any moment in the cycle, it is necessary to press the stop-cycle push button 22 ('STOP' push button) for a time of at least 2 to 3 seconds. In this case the telltale light 23 described hereinbefore is lit and the memory 31 is not set to zero. Consequently it is possible to open the door of the machine, if there is no water in the tub and with the motor stationary. By pressing the 'START' push button 21, the machine starts again from the exact point at which it was stopped. If there is a failure in the main power supply 29, the circuitry of the electronic programmer is supplied with power by way of the auxiliary supply 30. The data relating to the operating phases which are being performed are immediately recorded in the memory 31, and when the main supply returns, the machine resumes functioning from the exact point at which it had been stopped and completes the previously selected operating cycle. Finally, it should be borne in mind that operation of the machine may take place only when the 'ON-OFF' push button 24 (main switch) is in the 'ON' position. When however the push button 24 is actuated to the 'OFF' position, the machine is disconnected from the electrical network and hence all the memorized cycle is set to zero. In this case it is necessary to return the push button 24 on the 'ON' position and to re-select the initial parameters, in the manner described hereinbefore.

## CLAIMS

1. An electronic programmer for controlling the operation of a machine comprising a plurality of manual selection means operable by the user for setting input data necessary for performance of a desired operating cycle controlled by the programmer, an input-output unit, at least one storage memory for storing the input data provided by said manual selection means, a microprocessor capable of controlling the performance of the operating cycles of a machine controlled by the programmer in dependence on data from said memory, and a plurality of low-power and high-power interface means respectively for connection to the control and visual display components of the machine and to operating components of the machine wherein each of said manual selection means is associated with a single respective parameter of the operating cycle of the machine and includes at least one electrical control means connectable to or disconnectable from said memory and said microprocessor by way of said input-output unit the electrical control means when in its connecting position being arranged to supply said memory and said microprocessor with a coded control signal corresponding to said parameter, and the microprocessor being arranged to send to said visual display components in reply to the control signals received, at least one coded setting signal corresponding to at least one complementary parameter of the operating cycle of the machine.
2. An electronic programmer according to Claim 1 wherein the electrical control means comprise a first group of conductors connected to the respective manual selection means and associated with respective parameters of the operating cycle, and a second group of conductors connected to said memory and to said microprocessor via said input-output unit, said first and second groups of conductors being arranged in a matrix and connectable together by means of user-operable elements.
3. An electronic programmer according to Claim 1 wherein the electrical control means comprise a digital multiplexer whose input is provided by a plurality of conductors connectable to a common reference voltage by way of respective switching contacts and associated with said parameters of the operating cycle of the machine, the multiplexer having an output connected to said memory and to said microprocessor by way of said input-output unit and being operated by means of address signals generated by said microprocessor.
4. An electronic programmer according to Claim 1 wherein said electrical control means comprise a plurality of potentiometers associated with said parameters of the operating cycle and having respective sliders connected to corresponding inputs of an analog multi-



plexer having an output connected to said memory and said microprocessor via an analog-to-digital converter and said input-output unit, said multiplexer being operated by means of address signals generated by said microprocessor.

5. A domestic washing machine having an electronic programmer, for controlling the operation of the machine, the programmer comprising a plurality of manual selection means disposed on a control panel of the machine for setting input data necessary for performance of a desired operating cycle of the machine, an input-output unit, at least one storage memory for storing the input data provided by said manual selection means, a microprocessor capable of controlling the performance of the operating cycles of the machine in dependence on the data from said memory, and a plurality of low-power and high-power interface means respectively connected to the control and visual display components of the machine, including electrically operated valves, safety devices, viewing means and warning lights and to the operating components of the machine including a motor and a discharge pump wherein each of said manual selection means is associated with a single respective parameter of the operating cycle of the machine, the parameters including type of and colour of fabrics and amount of clothing to be washed and includes at least one electrical control means connectable to or disconnectable from said memory and said microprocessor by way of said input-output unit, the electrical control means when positioned in its connecting position being arranged to supply said memory and said microprocessor with a coded control signal corresponding to said parameter, the microprocessor being capable of sending to said visual display components in reply to the control signals received, at least one coded setting signal corresponding to at least one complementary parameter of the operating cycle of the machine including the amount of detergent to be put in the machine for optimisation of said cycle.

6. An electronic programmer constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

7. A washing machine constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

8. A washing machine incorporating an electronic programmer according to any one of claims 1 to 4 and 6.

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**ASSIGNEE-INFORMATION:**

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**ABSTRACT:**

CHG DATE=19990617 STATUS=O> A microprocessor (28) based electronic sequence programmer for use e.g. in a washing machine is arranged to control the machine (via interface 33) through an operating cycle with various parameters of the machine being set in accordance with stored (at 31) values appropriate to the operating cycle. The programmer causes the display (through interface 32) of suitable values of parameters (e.g. in its

application to a washing machine, the amount of detergent to be used) which are set by the microprocessor, in accordance with other parameters (e.g. fabric type, colour, load and degree of soiling of the clothes to be washed) selected (at 26) by the operator. The sequence of operations controlled by the microprocessor then represents an optimum in terms of energy consumption and operating effectiveness. □